location for determining representative horizontal curve collision characteristics. The reporting threshold for data collection and reporting in NC is a collision that resulted in a fatality, non-fatal personal injury, property damage of $1,000 or more, or property damage of any amount to a vehicle seized (*NCDMV 2006*). The North Carolina Department of Transportation (NCDOT) controls almost 80,000 miles of roadways, which creates consistency across the state with roadway design, construction, and maintenance. These factors make findings based on NC collision data useful to many other jurisdictions.

4.2 Literature Review

There are many studies identifying collision characteristics and geometric design features that have an impact on collisions. The following studies all address horizontal curve collisions. They also identify horizontal curves as causal factors in highway collisions and indicate that curves have a significantly higher collision rate than tangent sections. Our purpose here is to see what curve characteristics and agency countermeasures have been identified and are most prevalent. Our literature review encompassed crash rates, roadway characteristics at curves, causal factors, and numerous potential treatments.

Garber and Kassebaum (2008) studied nearly 10,000 collisions on urban and rural two-lane highways in Virginia finding the predominate type of collision to be run-off-the-road collisions. The significant causal factors of these run-off-the-road collisions included roadway curvature and traffic volume as determined through a fault tree analysis. The countermeasures identified to mitigate run-off-the-road collisions include widening the roadway, adding advisory signs or chevrons to sharp curves, and adding or improving shoulders. However, this study did not specifically address curve collisions nor did it indicate how many of the collisions were on curves.

McGee and Hanscom (2006) provide a publication on low-cost countermeasures that can be applied to horizontal curves to address identified or potential safety problems. These countermeasures included: basic traffic signs and markings from the MUTCD, enhanced TCDs, other TCDs not mentioned in the MUTCD, rumble strips, minor roadway improvements, and innovative and experimental countermeasures. For every countermeasure, the authors concisely identified a description of the countermeasure, an application guideline, design elements, its effectiveness, cost, and maintenance, and additional sources of information.

In Volume 7 of NCHRP Report 500, Torbic et al. (2004) provided strategies to improve the safety of horizontal curves. This study had two primary purposes. The first was to reduce the likelihood of a vehicle leaving its lane and either crossing the roadway centerline or leaving the roadway at a horizontal curve. The other purpose was to minimize the adverse consequences of leaving the roadway at a horizontal curve. To accomplish these research objectives, twenty detailed strategies were described as countermeasures for reducing curve-related collisions. Each strategy included a general description, an estimate of the effectiveness of each countermeasure, and special issues pertaining to horizontal curves. These countermeasures addressed traffic control devices, markings, sight distances, and horizontal alignments.